TAXONOMY OF POLYGONUM, SECTION POLYGONUM (AVICULARIA) IN NORTH AMERICA

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The limits of *Polygonum* sect. *Polygonum (Avicularia)* have been defined by Hedberg (1946) in an illuminating study of pollen morphology in *Polygonum* and related genera. Excluded are most of the native species of North America, now regarded as belonging to *Polygonum* sect. *Duravia*. Within sect. *Polygonum,* however, there has been little agreement as to specific limits in North America (Fernald, 1950; Gleason, 1952; Löve and Löve, 1956) or elsewhere.

Styles' (1962) excellent biosystematic treatment of this group in the British Isles appeared to offer some orientation for the possible resolution of its complexities in North America. We have addressed ourselves specifically to two problems: 1. The identity of certain populations found in Marin Co., California, and heretofore referred to *P. fowleri* Robins. (Howell, 1949); and 2. The resolution of the complex referred to *P. aviculare* L. in North America, especially in the western United States. The solution of these problems has demanded a consideration of all species of the group in North America, and certain critical observations made during the course of this work will be reported here. Thus the present paper is a preliminary survey of the North American species[1].

Four species of *Polygonum* sect. *Polygonum* found in North America have inflorescences that appear terminal, the flowers being more or less clustered at the summits of the stems among very reduced leaves or bracts. *Polygonum tenue* Michx., morphologically similar to this group, has pollen of the *Duravia*-type, and is presumably referable to that section. The four species that do belong to sect. *Polygonum,* occur in North America, and appear to have terminal inflorescences are *P. arenarium* Waldst. & Kit., *P. argyrocoleon* Steud. ex Kunth, *P. patulum* Bieb. (*P. bellardii* auct., non All.) and *P. ramosissimum* Michx. The first three of these species are introduced from Eurasia, the last a native of North America. We concur with Gleason (1952) in considering *P. exsertum* Small (type, US!) a synonym of *P. ramosissimum*. In this species, as in some of those that will be discussed below, enlarged, olivaceous achenes are sometimes formed, particularly late in the season (Styles, 1962). Such fruits are usually flattened and wrinkled but perfectly viable. They are very different in form from the normal fruits borne by the same plant. In this species, normal fruits are mostly 2.75–3.25 mm long and 1.75–2 mm wide, whereas late-season fruits are

[1] This study was carried out at Stanford University while the senior author held National Science Foundation Faculty Fellowship 63115. The authors are most grateful to B. T. Styles and to J. T. Howell for their suggestions concerning this paper.

3.75–5.4 mm long and 1.5–2.4 mm wide. Plants that have been referred to *P. exsertum* have a high proportion of distended fruits. We are unable to account for the report by Löve and Löve (1956) of 2n = 20 in *P. ramosissimum* and 2n = 60 in *P. exsertum* and suggest that chromosome counts be made of a wide range of material before these numbers be associated with morphologically defined entities. Some of the material named *P. exsertum* in herbaria is not *P. ramosissimum* but rather the analogous late-season form of *P. prolificum* (Small) Robins., a species discussed below.

The remaining North American species of sect. *Polygonum,* in which the flowers are scattered along the stem, may be separated by the following key.

Achenes shining.
- Fresh foliage conspicuously glaucous; ocreae of lower nodes very conspicuous, 7–10 mm long; Atlantic coast ..... 1. *P. glaucum*
- Fresh foliage not conspicuously glaucous; ocreae less than 8 mm long, not conspicuous.
  - Fruits sublustrous; undistended fruits about 2 mm long ..... 2. *P. prolificum*
  - Fruits glossy; undistended fruits 2.8–4.7 mm long.
    - Undistended fruits 4–4.7 mm long; distended fruits to 5.75 mm long. 3. *P. oxyspermum*
    - Undistended fruits 2.8–3.4 mm long; distended fruits to 4.6 (–5) mm long. 4. *P. marinense*

Achenes dull.
- Perianth bottle-shaped, constricted just below the apex; leaves blunt, oblong; achenes about 3 mm long ..... 5. *P. erectum*
- Perianth not constricted below the apex.
  - Achenes abruptly beaked, granular ..... 6. *P. fowleri*
  - Achenes not abruptly beaked, not notably granular.
    - Branch leaves much smaller than the stem leaves; fruiting perianth divided nearly to the base; fruit with 3 equal concave sides.
      - Stem leaves subsessile or with petioles included in the ocreae; fruits 2.5–3.5 long ..... 7. *P. aviculare* s. str.
      - Stem leaves with petioles 4–8 mm long projecting from the ocreae; fruits 3.5–4.5 mm long ..... 9. *P. boreale*
    - Branch leaves and stem leaves subequal; fruiting perianth divided about half its length; fruit with 2 convex and one shorter concave side. 8. *P. arenastrum*

1. *P. glaucum* Nutt. A very distinctive species of the sands of the Atlantic Coast from Massachusetts to Georgia, with very large ocreae, *P. glaucum* has occasionally been recorded as the west Eurasian and North African *P. maritimum* L., which is a perennial and differs in several other characters. It has not been confused with other species in this treatment. Löve and Löve (1956) have reported 2n = 40 in *P. glancum.*

2. *P. prolificum* (Small) Robins. This species has sometimes been confused with *P. ramosissimum,* but can be distinguished by its short pedicels (included within, rather than exserted from, the ocreae) and less shiny fruits. Its flowers are not markedly clustered at the apex of

the stems. It is widespread across the United States and southern Canada, but commoner in the central and eastern portions of the continent. It can be reported, probably for the first time, from California, on the basis of the following collection: Cuttings Wharf on Napa River, Napa Co., 8 Oct. 1932, *Howell 10800* (CAS). At this locality, and over much of the remainder of its range, it is doubtless introduced; but it is known only from North America and must therefore be native there.

3. *P. oxyspermum* Meyer & Bunge ex Ledeb. In North America this species occurs in a very small area in eastern Canada (Newfoundland, New Brunswick, and Nova Scotia). It is widely distributed on the coasts of northwestern Europe and may be introduced in North America, as suggested by Hultén (1963) for a number of species with similar distribution patterns. Styles (1962) pointed out that the differences between *P. oxyspermum* and *P. raii* Babington were not constant, and reported a chromosome number of $2n = 40$ for representatives of both entities from Europe. Later, Webb and Chater (1963; 1964) considered *P. raii* a subspecies of *P. oxyspermum,* making the combination *P. oxyspermum* ssp. *raii* (Babington) Webb and Chater (1963). Styles described the fruits of *P. raii* as being 5–6 mm long and 3–3.5 mm wide, but his illustration (Styles, 1962, pl. 9) shows them as ranging from 4–5 mm in length and from 2.4–3.2 mm in width. On the other hand, his illustration of *P. oxyspermum* shows enlarged fruits that are apparently comparable to the late season fruits of *P. ramosissimum* discussed above. These fruits are 5–6.1 mm long, and paler than the normal ones. Webb and Chater (1964) consider *P. oxyspermum* ssp. *oxyspermum* to have fruits 5–6.5 mm long, and ssp. *raii* fruits 2.5–5.5 mm long. Thus the differences between the two subspecies may depend on the proportion with which they produce distended fruits late in the season (or earlier?). In the small amount of European material named *P. raii* that we have examined, the fruits are mostly 4.5–5 mm long. North American specimens we examined had normal fruits 4–4.7 mm long and 2.5–3.2 mm wide, and occasionally abnormal ones (as in the collection that is the type of *P. acadiense* Fernald) to 5.75 mm long. Thus they seem to fall in the same range of the European material. We have determined a very large series of this species (DAO, GH, NMC, US) as *P. oxyspermum,* since subspecific lines in the European material may or may not be applicable in North America. Löve and Löve's counts of $2n = 80$ (perhaps from a cell with doubled chromosome number?) in *P. oxyspermum* and $2n = 60$ in *P. raii,* both from North American material, need to be confirmed.

4. **P. marinense** Mertens & Raven, sp. nov. A *P. oxyspermo* differt: achaeniis minoribus, 2.8–3.4 mm longis, 1.9–2.3 mm latis, interdum ad 4.6 (–5) mm longis, 2.5 mm latis, refertis, subplanis, subrugosis; sepalis ex comparatione angustiore hyalinomarginatis; pedicellis filiformis, 2–5.5 mm longis, floribus fructibusque saepe longe ab ocreis exsertis; chromosomata $2n = 60$.

Type: Marin Co., Calif., common in salt marshes at the head of Drake's Estero, Point Reyes Peninsula, 22 Aug. 1961, *Raven 16568* (DS). Growing up among mats of *Salicornia virginica* and *Distichlis spicata.*

Additional specimens examined: California. Marin Co.: salt marshes, Burdell, *Howell 21282* (CAS, DS); Escalle salt marsh, *Howell 19396* (CAS); salt marsh, Inverness, *Howell,* 1945 (CAS); saline marsh, north of Inverness, *Nobs* & *Smith 912* (CAS, DS); salt marsh at head of Drake's Estero, *Howell 25326* (CAS).

This distinctive new species is entirely different from *P. fowleri,* with which it has been confused, but very similar to *P. oxyspermum.* It differs from the latter in its smaller fruits, normally 2.8–3.4 mm long, and even when distended only up to 4.6 (–5) mm long; its longer, more slender pedicels in fruit; its more narrowly margined sepals; and its less conspicuous ocreae. In addition, its chromosome number is $2n = 60$ (progeny of the type collection), not $2n = 40$.

Polygonum robertii Lois. is a name that has been associated with a similar group of plants found on the shores of the western Mediterranean. These plants are said often to be perennial and to have shining achenes 2–3 mm long. Styles (1962) excluded them from his concept of *P. raii,* but Webb and Chater (1964) include them in their concept of *P. oxyspermum* ssp. *raii.* Consequently, Webb and Chater considered this taxon to have achenes 2.5–5.5 mm long. Whether these Mediterranean plants are in fact conspecific with *P. oxyspermum* or with *P. marinense* (geographically there is more in favor of the latter hypothesis than the former), there is considerable doubt about the correct application of the name *P. robertii* Lois. (Styles, 1962; Webb and Chater, 1964). *Polygonum marinense* is certainly not conspecific with *P. oxyspermum,* and even if it is found to include the plants of the western Mediterranean, there is apparently no earlier, valid, certain name for these. The native status of *P. marinense* in North America must for the present remain doubtful.

5. *P. erectum* L. This very distinctive species, which occurs from the region of the Rocky Mountains east to the Atlantic seaboard, should not be confused with the taxon called *P. aviculare* L. var. *erectum* (Roth) Koch, which is generally considered a synonym of *P. aviculare* s. str. Löve and Löve (1956) reported a somatic chromosome number of $2n = 40$ for this species and $2n = 20$ for *P. achoreum* Blake, but as we are unable to find any character to distinguish these two entities satisfactorily, we believe that it would be desirable to reinvestigate this complex cytologically.

6. *P. fowleri* Robins. This species ranges from Maine north to Newfoundland, across the continent to Alaska, and south at least to the vicinity of Puget Sound, Washington. It is perhaps the most distinctive entity in the entire group. Its achenes are 2.75–3.5 mm long and 1.75–2.25 mm wide. Enlarged late season achenes are relatively rare, and are up to 4.25 mm long and 2.25 mm wide. A high incidence of biconvex fruits is also characteristic. Plants from Marin Co., California, hitherto referred to this species (Howell, 1949; Munz, 1959) are totally different

and have been described above as *P. marinense*. We have examined the type of *P. fowleri* (GH) and a large series of specimens from throughout its range. We have also examined the type of *P. allocarpum* Blake (US) and a series of specimens referred to that species. Like Gleason (1952) we are unable to distinguish this entity consistently from *P. fowleri,* and are thus unable to account for the somatic chromosome numbers 2n = 40 for P. *fowleri* and 2n = 60 for *P. allocarpum* that have been reported by Löve and Löve (1956).

7. *P. aviculare* L. s. str. and 8. *P. arenastrum* Jord. ex Bor. With *P. boreale* (no. 9), these species constitute the North American members of the *Polygonum aviculare* complex. Thev are characterized by their dull, striate fruits and flowers in axillary fascicles. Styles (1962) divided this complex in Britain into 4 species: *P. arenastrum* Jord. ex Bor., *P. aviculare* L. s. str., *P. boreale* (Lange) Small, and *P. rurivagum* Jord. ex Bor. The last-mentioned entity is not known from North America, the plants described bv Löve and Löve (1956) as this species not agreeing with those treated under this name in Europe (Styles, 1962).

In Britain, the distinction between *P. arenastrum* and *P. aviculare* is rather sharp. Styles (1962) characterized *P. arenastrum* as having branch leaves about the same size as the stem leaves; persistent perianth divided about half its length; and fruits 1.5–2.78 mm long, with two convex and one narrowly concave side (rarely with two concave and one convex side). The chromsome number in this species was determined as 2n = 40. In *P. aviculare* s. str. the branch leaves are smaller than those of the main stem (this is most evident in young plants); the persistent perianth is divided almost to the base; and the fruits are 2.5–3.5 mm long, with three more or less equal concave sides. The chromsome number is 2n = 60. It should be pointed out that Lindman (1912) in an early paper on this group called *P. aviculare* s. str. P. *heterophyllum* Lindm. and *P. arenastrum P. aequale* Lindm., and that Löve and Löve (1956) called *P. aviculare* s. str. *P. heterophyllum* and *P. arenastrum P. aviculare.*

It became evident early in the course of our study that most of the North American collections referred to *"P. aviculare"* were *P. arenastrum,* and that plants referrable to this species occurred throughout the temperate United States and southern Canada, and were occasional farther north. We determined the chromosome number 2n = 40 in two collections typical of this species: one from the Stanford University campus, Santa Clara Co., Calif., *Mertens 3* (DS), the second from Muncie, Indiana, *Mertens 10* (DS). In addition, this chromosome number was found in the root tips of germinating seeds from a collection from the serpentine area at Magalia, Butte Co., Calif., *Howell 37564* (CAS). In this collection, the achenes were nearly triangular in transection and ranged from 2.5–2.75 mm long. The perianth likewise was divided about ⅔ of its length, and the plant appeared to be relatively heterophyllous. As Styles (1962) points out, however, accurate determi-

nations of heterophylly can be made only in young, well grown plants. We encountered numerous collections which we referred to *P. arenastrum,* largely on the basis of fruit size, which did not have the characteristic single narrow concave side of this species; but we have likewise seen similar collections from southern Europe.

We have determined the chromsome number characteristic of *P. aviculare,* 2n = 60, in the following two collections: about 5 miles north of Santa Cruz, Santa Cruz Co., Calif., along edge of an irrigated brussels sprout field, *Mertens 5* (DS); State Highway 1 about 2 miles north of Santa Cruz Co. line, San Mateo Co., Calif., *Mertens 6* (DS). Although the perianth in these collections was deeply divided and the fruits typical of *P. aviculare* in transection, the fruits, very small for this species, were 2.25–2.5 mm long. Moreover, the plants were not appreciably heterophyllous. Both the small fruit size and the lack of heterophylly of these collections may have been attributable to the fact that both were late season plants which, growing in irrigated ground, had been flowering for a very long time before they were collected in late September. Nevertheless, they would have been most difficult to determine as *P. aviculare* had their chromsome number not been determined. Because we have seen relatively few collections from North America that were *P. aviculare,* it appears to be worthwhile to cite these. Doubtless it is much commoner than would appear here, as these weedy plants are poorly collected.

Alaska. Skagway, *Eastwood 734* (CAS). Yukon Territory. Moosehide Mountain, *Calder & Billard 4549* (CAS). British Columbia. Atlin, *Setchell & Parks,* 1930 (CAS). Alberta. Near Fort Saskatchewan, *Turner 33* (CAS). Idaho. Kootenai Co.: valley of Lake Pend d'Oreille, *Sandberg* et al. *966* (CAS). Nez Perces Co.: near Forest, *Brown 18* (DS). Nevada. Mineral Co.: Wassuk Range, *Archer 7165* (DS). Washoe Co.: Reno, *Eastwood 14795* (CAS). California. Del Norte Co.: Crescent City, *Van Deventer,* 1934 (CAS); *Kildale 1030* (DS). Humboldt Co.: near Cape Mendocino, *Wolf 1208* (DS). Shasta Co.: Mt. Shasta, *Cook 15403* (DS). Yolo Co.: Davis, *Goodwin,* 1932 (DS). Madera Co.: Red's Meadows Pack Station, *Raven 3666* (CAS) Mono Co.: Hilton Creek, *Howell 27389* (CAS, immature). Sonoma Co.: Petaluma, *Eastwood 10476* (CAS). Marin Co.: Almonte salt marsh, *Howell 14814* (CAS); Greenbrae, *Howell 19428* (CAS). San Francisco: *Howell 32667* (CAS). San Mateo Co.: Redwood City, *Thomas 8784A* (DS; with *P. arenastrum*). Santa Clara Co.: near Mountain View, *Thomas 7239* (DS). Santa Cruz Co.: Pajaro River, *Thomas 3222* (DS). San Benito Co.: Hollister, *Raven 2150* (CAS). Tulare Co.: Terra Bella, *Howell & Barneby 29200* (CAS). Ventura Co.: Ojai Valley, *Pettibone & Hubby,* 1894 (CAS). San Bernardino/Riverside Co.: Jurupa Mountains west of Colton, *Kamb 763A* (CAS).

In concluding this section it can be stated that *P. arenastrum* is much commoner than *P. aviculare* in North America and that both are more variable than would be suspected from the descriptions of Styles (1962). In general certain identifications can be made of plants with the characteristic fruit shape of *P. arenastrum* or with fruits averaging shorter than 2.25 mm; or of plants with fruits longer than 2.75 mm. Well grown plants with fruits between 2.25 and 2.75 mm in length are likely to be

P. arenastrum particularly if they are not heterophyllous and have the perianth divided about half of its length. The identification of late season plants with fruits falling in this range is likely to be problematical in the absence of chromosome counts; on statistical grounds they are most likely to be *P. arenastrum*. The identity of the plants discussed by Löve (1956) as *P. buxiforme* Small with a reported chromosome count of 2n = 20, must remain problematical for the time being. Their *P. neglectum* Bess. and *P. aviculare* L., both with 2n = 40, are probably *P. arenastrum*, and their *P. heterophyllum* Lindm. and *P. littorale* Link, 2n = 60, *P. aviculare* L. Both of these species are introduced in North America.

9. *P. boreale* (Lange) Small. We have not seen specimens of this species from North America, but it has been reported from Arctic regions in this continent and is probably present.

Doubtful and excluded species. On the basis of the material we have seen, we are unable at present to evaluate the status of *P. autumnale* Brenkle (said by Löve and Löve, 1956, to have 2n = 20), *P. latum* Small (said by Löve and Löve, 1956, to have 2n = 40), and *P. montereyense* Brenkle (sect. *Duravia?*). A biosystematic study conducted along the lines of that carried out on British species by Styles (1962) would be necessary to evaluate the badly oversplit entities recognized in this group by some authors, notably Löve and Löve (1956), on the basis of very little evidence. Since these authors cite no specimens to document their chromosome number determinations, these reports must, in such a critical group, be disregarded.

One additional species of this group, *P. polycnemoides* Jaub. & Spach, has been reported by Hitchcock (1964, p. 163) from Idaho and New York; it is said to have shining achenes and to be distinguished from *P. aviculare* (sens. lat.) by its nonstriate, scaberulous-papillate and strongly angled stems, larger, less deeply lacerate stipules, and papillate perianth. It is a native of southern Asia, and, as suggested by Hitchcock, may occur more widely in North America than reported.

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A REEVALUATION OF BUDDLEIA CORRUGATA

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As a thesis at the L. H. Bailey Hortorium, Cornell University, I prepared a revision of the North American species of *Buddleia* (Loganiaceae). This revision has not yet been published. However additional material from Baja California, Mexico, has recently become available which has made it necessary to alter the interpretation of two species treated in the thesis.

Buddleia corrugata was first collected by Marcus Jones at Arroyo Hondo (he spelled it Undo), Loreto, in October 1930. This locality lies at an altitude of approximately 2000 ft. on the north side of Cerro Giganta. The type collection is quite depauperate. Now with additional collections from several areas of Baja California, the species can be much better defined and the variability better evaluated. Material from the Cape Region which had been interpreted in my thesis as a different, if closely allied species, should be regarded as a subspecies of *corrugata*. Two recent collections from the area of Volcan Las Tres Virgenes are very similar to the type in morphology and it seems best to treat them also as a subspecies.

The pattern of variation in *B. corrugata* may be a reflection of the geologic history of Baja California. During pre-Pleistocene time the Cape Region was cut off repeatedly from the northern part of the peninsula (Durham and Allison, 1960) thus isolating the two areas and allowing divergent evolution to take place. The volcanic peaks of Las Tres Virgenes which arose in late Miocene (Savage, 1960) similarly provided an area where ecotypic variation could develop.

Key to the Subspecies

Leaves ovate, 0.7–3.0 cm broad.
  Lower surface of the leaves with erect pubescence, the stellate hairs candelabra; calyx 2.0–2.5 mm long; corolla 2.5–3.7 mm long; capsule 1.5–2.0 mm long ..... *B. corrugata* ssp. *corrugata*
  Lower surface of the leaves with appressed pubescence, the stellate hairs mostly simple; calyx 3.0–4.0 mm long; corolla 4.0–5.5 mm long; capsule 2.5–3.0 mm long ..... *B. corrugata* ssp. *gentryi*
Leaves linear, 0.2–0.3 mm broad ..... *B. corrugata* ssp. *moranii*